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SPACE LAUNCH SYSTEM PROGRAM (SLSP) RISK AND OPPORTUNITY MANAGEMENT PLAN

REVISION AND HISTORY PAGE

Status	Revision No.	Change No.	Description	Effective Date
Baseline	–		Baseline per PCBD SV2-01-0080, dated 3/14/13; (CR SLS-00105); PCN SV00212	3/14/13

NOTE: Updates to this document, as released by numbered changes (Change XXX), are identified by a black bar on the right margin.

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1.0 INTRODUCTION

The Space Launch System (SLS) Program management team has developed a risk and opportunity management plan that implements NASA, Explorations Systems Development (ESD) Division, and MSFC risk management requirements detailed in NPR 8000.4A, Agency Risk Management Procedural Requirements, ESD 10003, Exploration Systems Development Risk Management Plan, and MWI 7120.6, Program, Project and Institutional Risk Management. These documents contain a strong foundation for risk management; therefore, in an effort to reduce duplication, the SLS Program Risk and Opportunity Management Plan focus is on the unique SLS Program implementation of the processes. Risk management in the SLS Program is closely integrated with other management and decision-making processes so that "risk" is not considered separately but is an inherent part of the information presented to decision makers.

1.1 Purpose

This plan describes how the NASA Risk Informed Decision Making (RIDM) and Continuous Risk and Opportunity Management (CRM) processes will be implemented across the SLS Program. It describes the SLS Program risk and opportunity management organization and designates the roles, responsibilities, and accountability. It also holds authority for risk identification, mitigation, and control, and defines how the SLS Program communicates and manages risk and opportunity.

1.2 Scope

This plan is implemented within the SLS Program, including Program Planning and Control (PP&C), Systems Engineering and Integration (SE&I), all Elements (Booster, Liquid Engines, Stages, Spacecraft and Payload Integration, Advanced Development, Ground Operations Liaison), and the SLS Program Safety and Mission Assurance (S&MA). This plan is applicable to risks associated with cost, schedule, performance (in regard to requirements, operations, and supportability), and safety.

SLS contractors follow the risk management guidance provided in their respective contracts. The Element Offices will provide the SLS risk management team insight into the contractors' risk management processes and risks.

1.3 Change Authority/Responsibility

The NASA Office of Primary Responsibility (OPR) for this document is the SLS Program Planning and Control (PP&C) Office, XP03.

Proposed changes to this document will be submitted by an SLS Program change request (CR) to the SLS Program Control Board (PCB) for disposition. All such requests will adhere to the SLS-PLAN-008, SLS Program Configuration Management Plan.

2.0 DOCUMENTS

2.1 Applicable Documents

The following documents are applicable to the extent specified. Unless otherwise stipulated, the most recently approved version of a listed document shall be used. In those situations where the most recently approved version is not to be used, the pertinent version is specified in this list.

SLS-PLAN-001	Space Launch System (SLS) Program Plan
SLS-PLAN-001, Appendix E	SLS Lessons Learned/Knowledge Management Plan
ESD 10003	Exploration Systems Development Risk Management Plan
NPR 8000.4A	Agency Risk Management Procedural Requirements
MWI 7120.6F	Program, Project and Institutional Risk Management
SLS-PLAN-008B	SLSP Configuration Management Plan
SLS-PLAN-047A	SLSP Technical Metrics Plan
SLS-PLAN-003 (Baseline Pending)	SLSP Systems Engineering Management Plan (SEMP)
SLS-PLAN-026	SLSP Security Management Plan (SMP)
SLS-RQMT-015A	SLSP Hazard Analysis Requirements

2.2 Reference Documents

The following documents contain supplemental information to guide the user in the application of this document.

NPR 7120.5E	NASA Program and Project Management Processes and Requirements
ESD 10010	Cross Program Safety and Mission Assurance Plan
NASA/SP-2011-3422	NASA Risk Management Handbook
NPR 2810.1A	Security of Information Technology
IMSC-PLAN-8000.4	MSFC Mission Support Risk Management Plan
SLS-PLAN-013A	Space Launch System (SLS) Program Safety and Mission Assurance (S&MA) Plan
SLS-RPT-102	SLSP Trade Studies
SLS-RPT-089	SLS Program Top Risk List

SLS-RPT-088	SLS SE&I Top Risk List
SLS-SPEC-032C	Space Launch System Program (SLSP) System Specification
NFS 1807.104	NASA FAR Supplement Acquisition Planning, General Procedures
NFS 1815.201	NASA FAR Supplement Contracting by Negotiation, Exchanges with Industry before receipt of proposals
NFS 1815.203-72	NASA FAR Supplement Contracting by Negotiation, Risk Management
NFS 1846.401	NASA FAR Supplement Quality Assurance, General
PIC 02-17	Procurement Information Circular, Government Quality Assurance Surveillance Plan (QASP) Guidance

3.0 ORGANIZATION

The SLS (level 2) risk management process utilizes existing SLS organizational board structures rather than having boards or panels specifically for risk management. The following sections describe some roles and responsibilities as they apply to the SLS RIDM and CRM processes.

3.1 SLS Management Model

SLS is using a management model that utilizes Program Office, Chief Engineers (CEs), Discipline Lead Engineers (DLEs), Lead Systems Engineers (LSEs), and Chief Safety and Mission Assurance Officers (CSOs), Figure 3-1. All participants have roles in the risk management process. The Program/Element managers, CEs and CSOs roles are addressed in the Board sections (sections 3.1 to 3.3) and detailed in NPR 8000.4A, Agency Risk Management Procedural Requirements and MWI 7120.6F, Program, Project, and Institutional Risk Management. LSEs and DLEs participate in the boards, but have additional functions in the risk management process.

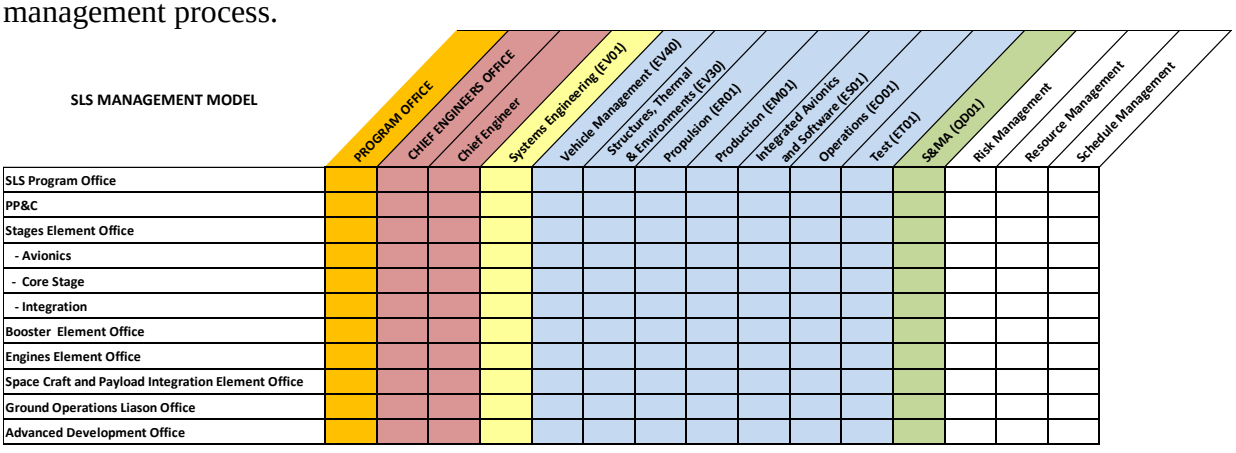


Figure 3-1. SLS Management Model

3.2 Roles and Responsibilities

3.2.1 Program Control Board

The SLS Program Control Board (PCB) serves as the program managers risk management board for RIDM and CRM activities. A full description of this Board is provided in SLS-PLAN-001, Space Launch System Program Plan.

For the RIDM activities, the Program Manager and PCB ensure that key decisions of the organizational unit are risk-informed. Examples of key decisions include: Architecture and design decisions, make-buy decisions, source selection in major procurements, budget reallocation (allocation of reserves). These decisions are documented in PCB minutes and/or Change requests or Directives in accordance with SLS-PLAN-008, Space Launch System Program Configuration Management Plan.

For CRM activities, the Program Manager and PCB approve the Top Program risks (risks to be listed on the Program Manager's Top Risk List). They also, monitor Top Program risks' mitigation progress and eventually "Close" or "Accept" these risks.

3.2.2 Chief Engineer's Control Board

The SLS Chief Engineer's Control Board (CECB) reviews SE&I risks and provides recommendations on those that should be considered Top Program risks. In addition, the Chief Engineer has the authority to provide mitigation resources to address risks brought to the CECB. The Chief Safety and Mission Assurance Officer (CSO), a member of the CECB is an active participant in the risk management process whose approval is required on risk safety scores (on risks that have a safety impact) before they proceed to the SLS PCB.

3.2.3 Element Control Boards

Element managers are responsible for the risk management processes in their areas. The element risk managers (RMs) work with their respective manager and team to implement the SLS risk management processes. Elements can elect to have risk boards or utilize their Element Control Boards (ECB) to work risks (i.e., approve, accept, close, and monitor risks). Element CSOs (ECSOs), as members of their respective ECBs, are active participants in the risk management process whose approval is required on risk safety scores (on risks that have a safety impact). Element prime contractors will also have risk management processes. The NASA Element RM has insight into the prime contractors risk management system and will work with their element team to communicate contractor's risks impact to SLS Program goals or risks that impact other elements or Programs (e.g., GSDO or MPCV) to the SLS Program.

3.2.4 Lead Systems Engineer and Element Lead Systems Engineers

Element Lead Systems Engineers (ELSEs) facilitate the systems engineering functions described in the SLS-PLAN-003, SLSP Systems Engineering Management Plan (SEMP). They also provide critical support to the risk management function by helping identify integration risks and associated risk handling strategies (e.g. mitigation or acceptance criteria). Risk owners work with

the ELSEs to review risks for potential integration threats. In addition, Risk Managers (RMs) shall keep ELSEs apprised of new and accepted risks, and risk mitigation activities.

3.2.5 Discipline Lead Engineers and Element Discipline Lead Engineers

Discipline Lead Engineers (DLEs) and Element Discipline Lead Engineers (EDLEs) provide technical expertise and integration across a technical area (e.g., avionics). They also provide critical support to the risk management function by helping identify technical risks, and associated risk handling strategies (e.g. mitigation or acceptance criteria). Risk owners work with the DLEs/EDLEs to review risks for potential integration threats. In addition, RMs shall keep DLEs/EDLEs apprised of new and accepted risks, and risk mitigation activities in their discipline area.

SLS Systems Engineering & Integration Organization	Systems Engineering	Vehicle Management	Structures, Thermal & Environments	Propulsion	Production	Integrated Avionics and Software	Operations	Test	Safety and Mission Assurance
Program Chief Engineer (CE)	Lead Systems Engineer (LSE)	Discipline Lead Engineer	DLE	DLE	DLE	DLE	DLE	DLE	Chief S&MA Officer
Stages Element Chief Engineer (ECE)	Element LSE (ELSE)	Element DLE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	Element CSO (ECSO)
Booster ECE	ELSE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	ECSO
Engines ECE	ELSE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	ECSO
Spacecraft and Payload Integration ECE	ELSE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	EDLE	ECSO
Advanced Development ECE									

Figure 3-2. SE&I Organization Structure

3.2.6 Security

Information and physical security functions have a risk management function described in NPR 2810.1A, Security of Information Technology, and SLS-PLAN-026, SLSP Security Management Plan (SMP). The SLS Risk Management Officer (RMO) supports the SLS security management team to perform the required risk management activities.

3.2.7 Program Planning and Control

The SLS PP&C Office provides four key functions that are integral to a successful risk management process: risk management, resource management, schedule management, and security risks. The roles of each function in the risk management process are outlined in the following sections.

3.2.7.1 Risk Management Function

SLS risk management integration is provided by the SLS PP&C Office. The SLS Program Risk Manager (RM) facilitates the SLS risk management processes across the Program. An extensive list of RM responsibilities is listed in NPR 8000.4A and MWI 7120.6F, Program, Project and

Institutional Risk Management. *Exception: The Prime contractor may utilize the SLS Risk Plan or their own corporate risk plan where the prime's risk manager responsibilities are addressed.*

3.2.7.2 Resource Management Function as It Applies to Risk Management

SLS resource managers work with the risk managers to identify and evaluate the cost impact of risks, and help identify mitigation costs. Budget shortfalls identified in the planning activities such as the Program Planning and Budget Execution (PPBE), may identify risks. The resource manager can enter or request the risk manager to enter these risks in the risk database. Resource managers should be consulted on cost impact values and funding for risk mitigation activities to ensure their validity.

The SLS Program/Element Resource Manager:

- Works with the risk owner to ensure when and how the cost impacts should be phased.
- Coordinates new cost impacts and updates existing cost impacts and mitigation costs with the risk owner, the element risk manager, and the other stakeholders, as required, prior to each SLS Monthly Program Review.
- Coordinates Program cost updates or changes with the SLS Risk Manager using the designated risk management database.

ESD requires program management to show the linkage between their Unallocated Future Expense (UFE) and the Program risk posture. SLS will assess the risks against the cost and schedule baseline using a quantitative risk assessment (QRA) and identify any UFE shortfalls to SLS management. Program management is expected to execute within their program UFE. Element risk and resource managers will provide support for the QRA's through identification of risks, mitigation steps, budget planning, cost impacts, liens, and risk mitigation funds. The ORA is discussed in detail in Section 4.2.5. Program management will inform ESD regarding the reserve usage and trends through Monthly Program Status Reviews (MPSRs) / Comprehensive Monthly Program Status Reviews (C-MPSRs). C-MPSR's are held on a quarterly basis where program management will present their updated Threats/Liens.. .

3.2.7.3 Schedule Management Function as It Applies to Risk Management

SLS schedulers work with the risk managers to identify schedule threat risks, evaluate schedule impacts, and capture approved risk mitigation activities in the schedule. Schedule threats identified in the planning activities (e.g., schedule baselining activity) may become risks. To improve efficiencies, approved risk mitigation plans should be tracked in the schedule. The risk owner, RM, and scheduler work together to move mitigation plans into the applicable schedule so that the risk owner only has to report mitigation start and completion dates to the scheduler. Key risk score changes, risk buy down, or increases in risk are still reported to the RM. Schedulers should be consulted on cost impact values and funding for risk mitigation activities.

3.2.8 Risk Owner

Risk owners, not necessarily the risk initiator, are individuals assigned to develop a risk package that describes the risk and associated risk handling strategies. They present this package to

appropriate boards for review and approval and then manage the risk research or mitigation activities. The risk manager works with the risk owner to prepare the risk package and enter the applicable data into the risk database (this does not preclude risk owners from entering data into the risk database). If the risk plan is tracked in the schedule, the risk owner keeps the scheduler apprised on the progress. When a risk is to be closed or accepted, the risk owner updates the risk package with closure or acceptance rationale and presents it to the applicable boards.

4.0 SLS RISK AND OPPORTUNITY MANAGEMENT

The SLS Program uses the NASA risk management approach that includes both Risk Informed Decision Making (RIDM) and Continuous Risk Management (CRM) process defined in NPR 8000.4A, Agency Risk Management Procedural Requirements, ESD's guidance in ESD 10003, Exploration Systems Development Risk Management Plan, and Center's guidance in MWI 7120.6, Marshall Work Instruction, Program, Project and Institutional Risk Management.

4.1 Risk Informed Decision Making

Risk Informed Decision Making (RIDM) is a fundamentally deliberative process that uses a diverse set of performance measures, along with other considerations, to inform decision making. The RIDM process acknowledges the role that human judgment plays in decisions, and that technical information cannot be the sole basis for decision making. This is not only because of inevitable gaps in the technical information, but also because decision making is an inherently subjective, values-based enterprise. In the face of complex decision making involving multiple competing objectives, the cumulative judgment provided by experienced personnel is an essential element for effectively integrating technical and nontechnical factors to produce sound decisions.

RIDM is invoked for key decisions such as architecture and design decisions, make-buy decisions, source selection in major procurements, and budget reallocation (allocation of UFE), which typically involve requirements-setting or re-baselining of requirements. Refer to NASA/SP-2011-3422, NASA Risk Management Handbook, for more information on RIDM.

The SLS Program implements the NASA six step RIDM process as described below:

Step 1 – Understand Stakeholders Expectations and Derive Performance Measures: Accomplished and documented in the SLS-PLAN-001, Section 3.2 Goals and Objectives and the technical performance measures (TPMs) listed in SLS-PLAN-047, SLSP Technical Metrics Plan.

Step 2 – Compile Feasible Alternatives. Compile a comprehensive list of feasible decision alternatives through a discussion of a reasonable range of alternatives. The result is a set of alternatives that can potentially achieve objectives and warrant the investment of resources required to analyze them further. SLS documents a list of trade studies in SLS-RPT-102, SLSP Trade Studies.

Step 3 – Set the Framework: The Framework is based on SLS-SPEC-032, Space Launch System Program (SLSP) System Specification, as well as Decision-Making Guidance in the SLS-PLAN-001, SLS Program Plan

and the Decision Analysis process summarized in the SLS-PLAN-003, SLSP Systems Engineering Management Plan (SEMP).

Step 4 – Conduct the Risk Analysis and Document the Results. Each engineering discipline can document their results in their trade studies or other quantified analysis. The SLS risk management team documents the approved risks in the milestone risk assessment reports and the risk database.

Step 5 – Develop Risk-Normalized Performance Commitments: A performance commitment is a performance measure value set at a specified percentile of the performance measure's probability density function (PDF). Performance measure and associated probability measures are described in SLS-PLAN-047, SLSP Technical Metrics Plan. Results of these discussions are reported during the SE&I Status to the Chief Engineer meetings and the MPSR. Documentation is recorded in the charts for these meetings and provided in a quarterly report to ESD. The TPMs listed in SLS-PLAN-047 and programmatic metrics listed in the Program monthly package ensure the basis for performance requirements baselines and risk tolerance measures are captured and tracked.

Step 6 – Deliberate, Select an Alternative, and Document the Decision Rationale: Each trade study lists the associated deliberation methodology (e.g., Kepner–Tregoe). The requirement analysis cycles (RACs) and design analysis cycles (DACs) and trade studies use cost, schedule, affordability, performance and programmatic measures, safety and other figures of merit (FOMs) to assess various alternatives. The risk management team supports these analyses and facilitates the development of risks that, for selected alternatives, make their way into the CRM process.

4.2 Continuous Risk Management

A risk is an event, whether known or unknown, that if it occurs may have a negative impact on a goal(s). It is measured with a likelihood of occurrence and severity of consequence (categorized as cost, schedule, performance, and/or safety). These risks will be assessed and a risk owner will be assigned to develop and then manage the approved risk. CRM is a systematic and iterative process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risks associated with implementation of designs, plans, and processes. This Plan only lists the unique SLS implementation steps (the full CRM process is fully described in NPR8000.4A, Agency Risk Management Procedural Requirements and MWI 7120.6F, Program, Project and Institutional Risk Management).

Risk statement per NASA/SP-2011-3422, NASA Risk Management Handbook, see the Figure below.

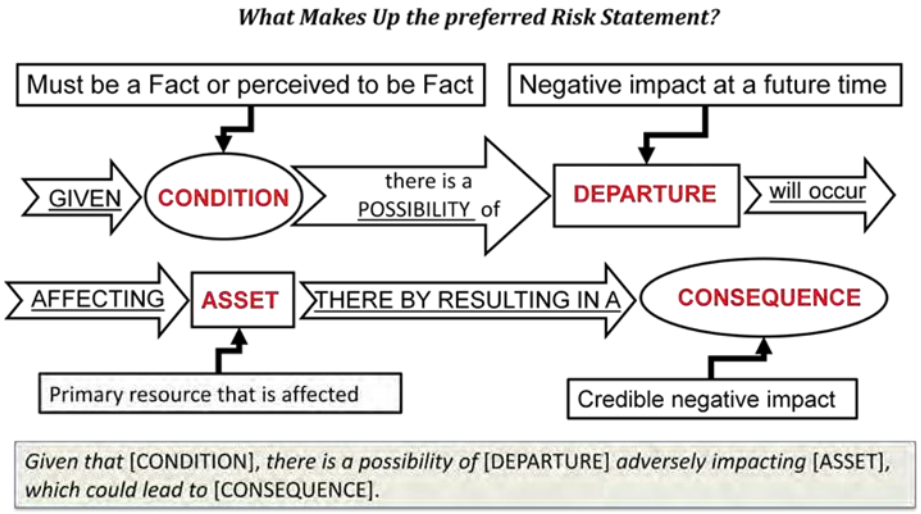


Figure 4-1. Risk Statement

4.2.1 Risk Identification

All SLS Program and Element team members are encouraged to submit concerns and to engage their SLS leads to work concerns internally (i.e., apply resources to address the concern). The person who identifies a potential risk or concern, referred to as "the initiator," should discuss the concern with his/her DLE, Lead Systems Engineer (LSE), Systems Engineering Lead Systems Engineer, Element Chief Engineer (CE), Systems Engineering Chief Engineer, Chief S&MA Officer (CSO), Health and Medical Technical Authority (HMTA) Delegate, SLS manager, or element equivalent personnel. This initial assessment should address the following:

- Is the concern a risk? (Could it result in an undesirable situation or circumstance and have a realistic likelihood of occurring?) If the concern is a risk, go to Section 4.2.2, Candidate Risk to Approved Risk Development.
- Is the concern already covered in forward work? (Then it is not a risk.)
- Can the concern be addressed by funds without going through the risk management process? (Management may decide to apply those funds and include it in forward work, and then it is not a risk, assuming the funded task provides full mitigation.)
- Is the concern a known risk (duplicative)? (Review the existing risk and if necessary update the description and context.)
- Is the concern an issue? (Not a risk because the likelihood is 100 percent – the threat has occurred.)
- Is the concern a budget lien or unfunded cost impact? (If it is, then it should be communicated to and captured by the resource management team.) NOTE: The unfunded cost impacts could also be documented and tracked in ARM.

4.2.2 Candidate Risk to Approved Risk Development

Element Candidate Risk Packages are initially reviewed and approved at the Element level. Next the RM works with the appropriate ELSE and the Element Manager or EDLE to determine if the risk is isolated to one Element, impacts the overall vehicle, affects multiple Elements (potentially a cross-element risk, called a linked risk in the Active Risk Manager (ARM) database), or affects multiple Programs (potentially a cross-program risk, termed "Exploration Systems Integrated" (ESI) risk). Similarly, when a risk is initiated in SE&I, the SLS SE&I RM will work with the appropriate LSE (or the Systems Engineering LSE) and DLEs to determine if the candidate is isolated to one element, has cross-element impacts, or cross-program impacts. If a risk has the potential to impact the vehicle, multiple Elements, or multiple Programs, it is presented to the Systems Engineering LSE (proceed to step 2). If the risk is isolated to one Element, it is managed according to Element risk management procedures.

In order to address each raised concern, the following six steps are systematically followed:

(1) Develop the Candidate Risk Package - After the concern raised by the initiator is determined to be a candidate risk, the initiator works with the element Risk Manager (RM), SE&I Risk Manager or RMO to develop a Candidate Risk Package that includes:

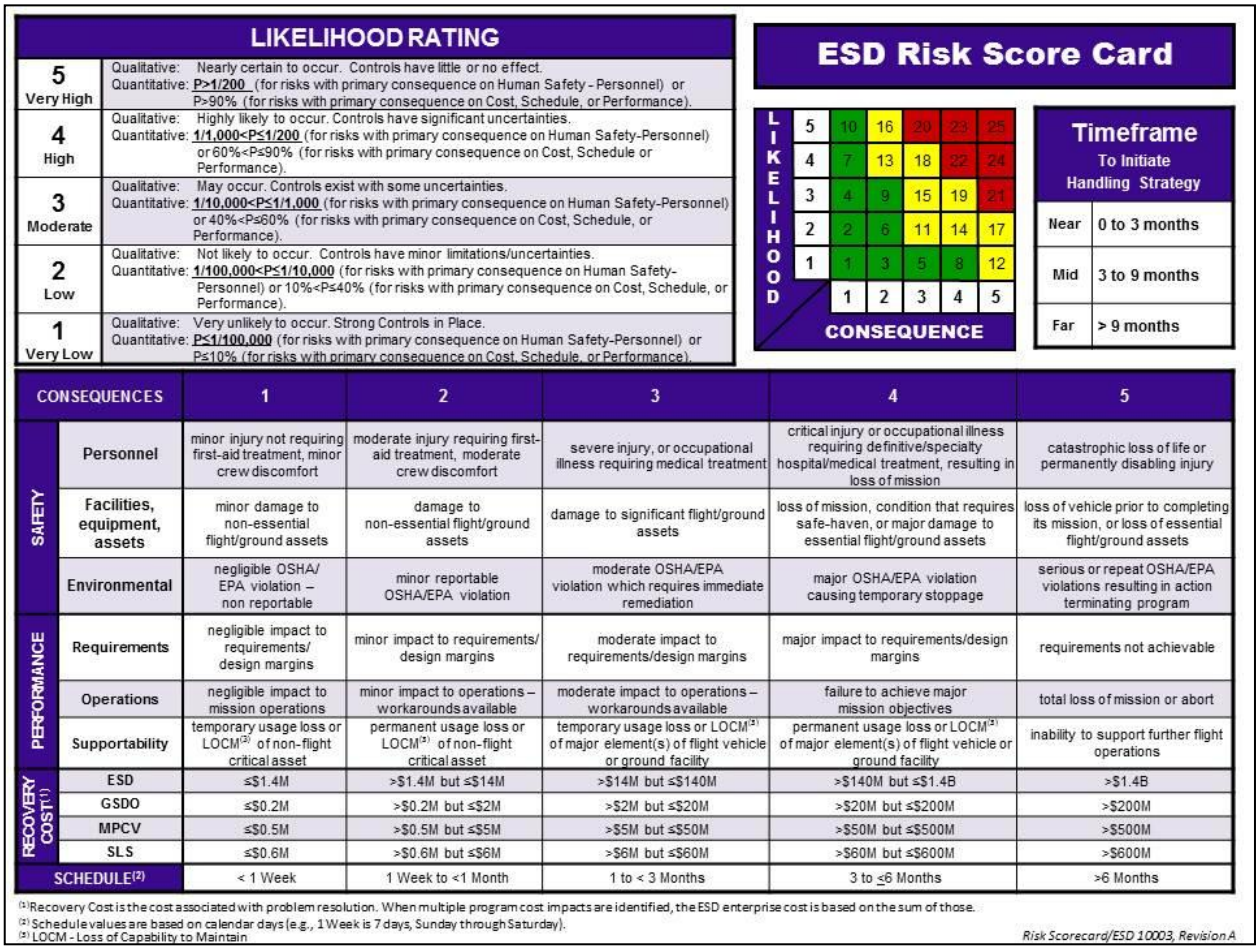
a. Risk Statement per NASA/SP-2011-3422, NASA Risk Management Handbook, see Figure 4-1, Risk Statement.

b. Description of the risk (Context).

c. Timeframe (timeframe to initiate the risk handling strategy).

d. Risk score (L×C), per SLS risk score card (Figure 4-2).

e. Recommended risk handling strategy (Mitigate/Accept/Research/Watch).



LIKELIHOOD RATING

5 Very High	Qualitative: Nearly certain to occur. Controls have little or no effect. Quantitative: P>1/200 (for risks with primary consequence on Human Safety - Personnel) or P>90% (for risks with primary consequence on Cost, Schedule, or Performance).
4 High	Qualitative: Highly likely to occur. Controls have significant uncertainties. Quantitative: 1/1,000<P≤1/200 (for risks with primary consequence on Human Safety-Personnel) or 60%<P≤90% (for risks with primary consequence on Cost, Schedule or Performance).
3 Moderate	Qualitative: May occur. Controls exist with some uncertainties. Quantitative: 1/10,000<P≤1/1,000 (for risks with primary consequence on Human Safety-Personnel) or 40%<P≤60% (for risks with primary consequence on Cost, Schedule, or Performance).
2 Low	Qualitative: Not likely to occur. Controls have minor limitations/uncertainties. Quantitative: 1/100,000<P≤1/10,000 (for risks with primary consequence on Human Safety-Personnel) or 10%<P≤40% (for risks with primary consequence on Cost, Schedule, or Performance).
1 Very Low	Qualitative: Very unlikely to occur. Strong Controls in Place. Quantitative: P≤1/100,000 (for risks with primary consequence on Human Safety-Personnel) or P≤10% (for risks with primary consequence on Cost, Schedule, or Performance).

ESD Risk Score Card

LIKELIHOOD	1	2	3	4	5
5	5	10	16	20	25
4	4	7	13	18	22
3	3	4	9	15	19
2	2	2	6	11	14
1	1	1	3	5	8

CONSEQUENCE

Timeframe To Initiate Handling Strategy	
Near	0 to 3 months
Mid	3 to 9 months
Far	> 9 months

	CONSEQUENCES	1	2	3	4	5
SAFETY	Personnel	minor injury not requiring first-aid treatment, minor crew discomfort	moderate injury requiring first-aid treatment, moderate crew discomfort	severe injury, or occupational illness requiring medical treatment	critical injury or occupational illness requiring definitive/specialty hospital/medical treatment, resulting in loss of mission	catastrophic loss of life or permanently disabling injury
	Facilities, equipment, assets	minor damage to non-essential flight/ground assets	damage to non-essential flight/ground assets	damage to significant flight/ground assets	loss of mission, condition that requires safe-haven, or major damage to essential flight/ground assets	loss of vehicle prior to completing its mission, or loss of essential flight/ground assets
	Environmental	negligible OSHA/ EPA violation – non reportable	minor reportable OSHA/EPA violation	moderate OSHA/EPA violation which requires immediate remediation	major OSHA/EPA violation causing temporary stoppage	serious or repeat OSHA/EPA violations resulting in action terminating program
PERFORMANCE	Requirements	negligible impact to requirements/ design margins	minor impact to requirements/ design margins	moderate impact to requirements/design margins	major impact to requirements/design margins	requirements not achievable
	Operations	negligible impact to mission operations	minor impact to operations – workarounds available	moderate impact to operations – workarounds available	failure to achieve major mission objectives	total loss of mission or abort
	Supportability	temporary usage loss or LOCM[3] of non-flight critical asset	permanent usage loss or LOCM[3] of non-flight critical asset	temporary usage loss or LOCM[3] of major element(s) of flight vehicle or ground facility	permanent usage loss or LOCM[3] of major element(s) of flight vehicle or ground facility	inability to support further flight operations
RECOVERY COST[1]	ESD	≤$1.4M	>$1.4M but ≤$14M	>$14M but ≤$140M	>$140M but ≤$1.4B	>$1.4B
	GSDO	≤$0.2M	>$0.2M but ≤$2M	>$2M but ≤$20M	>$20M but ≤$200M	>$200M
	MPCV	≤$0.5M	>$0.5M but ≤$5M	>$5M but ≤$50M	>$50M but ≤$500M	>$500M
	SLS	≤$0.6M	>$0.6M but ≤$6M	>$6M but ≤$60M	>$60M but ≤$600M	>$600M
SCHEDULE[2]		< 1 Week	1 Week to <1 Month	1 to < 3 Months	3 to ≤6 Months	>6 Months

[1] Recovery Cost is the cost associated with problem resolution. When multiple program cost impacts are identified, the ESD enterprise cost is based on the sum of those.
[2] Schedule values are based on calendar days (e.g., 1 Week is 7 days, Sunday through Saturday).
[3] LOCM - Loss of Capability to Maintain

Risk Scorecard/ESD 10003, Revision A

Figure 4-2. Risk Score Card

(2) Review the Candidate Risk Package - For risks that only affect a single element or SE&I, the element RM and initiator/risk owner work with the Element team (ELSE, ECE, ECSO, Element Manager), or SE&I equivalent personnel, to review and maintain the risk in accordance with risk management procedures. The approved risks are documented in the ARM.

(3) Cross-Program (ESI) or Cross-Element Risk Review - For potential cross-program/cross- element risks go to the SE&I weekly Team Meeting. Prior to presenting the risk at the SE&I meeting, the RM and risk owner work with the LSE/ELSE to schedule a review of the risk package. The LSE meeting is used to pre-screen the risk to ensure it is: (1) correctly stated (Risk Statement), (2) scoring is correct (L×C and Timeframe), and (3) handling strategy is integrated across the vehicle (and/or Programs).

At this point the risk owner will incorporate the recommendations and work with the RM to get the risk entered into or updated in the ARM risk database.

(4) Cross-Program or Cross-Element Risk Approval - The potential cross-program/cross-element risks that complete the LSE screening go to the SLS Chief Engineer Control Board (CECB) where they are reviewed and approved. This approval signifies concurrence with cross-program/cross-element status.
The CE decisions include:

a) The correct handling strategy is listed.
b) To resource the handling strategy (e.g., utilize existing CE funding to mitigate a risk) or to go to the SLS Program for resources or risk acceptance.

Note 1: The RM and risk owner work with the applicable scheduler to add the approved risk mitigation activities to the schedule for risk tracking.

Note 2: If the mitigation plan requires a baseline change, the risk package follows the Configuration Management (CM) Process for Change Process Flow outlined in SLS-PLAN-008.

c) Is the risk to be tracked at the DLE level (risk folders have been setup in ARM under the CE risk level folder for each DLE) or the CE level (these risks are listed on the CE's Top Risk List)?
d) Is the risk a cross-element risk impacting another SLS Element(s)?
e) Is the risk a cross-program (ESI) risk, or does it impact another program and/ or require mitigation help from another program? If yes, the cross-program risk process in ESD 10003 is followed.
f) Is the risk to be escalated to the SLS Program Top Risk List?
Note: The PCB approves the SLS Program Top Risk List.

(5) Risk Handling and Tracking - Next, Program and Element boards implement the risk handling strategy (e.g., mitigate, accept, research, watch, or close). Risk Managers facilitate this process and help track risks in ARM.

(6) Cross Program Risk Transfer - The SLS Risk Manager presents any risk recommended for transfer to SLS from ESD or the Integrated Risk Working Group (IRWG) (multi program risk group defined in ESD 10003) to the SLS CECB. If the CECB agrees to take ownership of the risk, an owning organization and risk owner is assigned.

4.2.3 Dissenting Opinion Reclama

When a concern or candidate risk is disapproved (rejected) the initiator can reclama the decision by following the Dissenting Opinions process defined in the SLS-PLAN-001, SLS Program Plan, Section 3.5.5.3.

4.2.4 Risk Escalation

Escalation of a risk facilitates the flow of risk information to upper management. Every risk should be considered for escalation to the next higher level management based on one of the following:

- A decision is needed at the next higher management level.
- Transfer of risk to another owning organization (from one Element to another Element or to a Program level). The receiving party must agree to take ownership of the risk.
- Request resources from the next level of management.
- Coordination/Integration is needed with other organizations/stakeholders whether inside or outside the Program, or both.
    - Cross-element risks shall be escalated to SLS SE&I.
    - Cross-program risks shall be identified by the risk managers and confirmed through cross-program communication. Once confirmed as an ESI risk, they will be marked in the database and presented in the MPSR. They will be escalated to ESD through the IRWG as needed.
- Awareness or visibility to the next higher management level.

Note: The SLS Risk Manager also communicates the cross-program risks with the ESD IRWG. The Working Group looks at the entire risk set and facilitates the ESI (cross- program) risk process (detailed in ESD 10003).

4.2.5 Quantitative Risk Assessment

Each Element updates their QRA on a monthly basis in preparation for the MPSR. Element resource managers work with their risk managers and team to identify each risk description, risk number (if previously entered into the database), the likelihood of the cost occurring, and the specific cost impacts by fiscal year. Each risk's cost impact is monitored (on the left side of the QRA template) on a monthly basis and tracked with a trend symbol, indicating whether the cost is new, or any decreasing or increasing changes in its status since the last month's QRA.

The cost impacts in the QRA are grouped by their likelihood percentage: greater than 50%, equal to 50%, and less than 50%. The risk total calculation at the top of the QRA adds up all the cost impacts (not including their mitigation costs) whereas the risk total with likelihood factored calculates the risk total multiplied by the likelihood factor for all risks that have a likelihood greater than or equal to 50%. The cumulative reserve over QRA calculates the difference between the total reserves and the risk cost totals with the likelihood greater than or equal to 50%. During the MPSR, Program management is briefed on the cost impacts that occur during the current and future years as well as cost impacts that have a current likelihood greater than or equal to 50%.

In addition to documenting cost impacts and mitigation funds in the risk database, a Quantitative Risk Assessment (QRA) is completed and briefed during the MPSR by each Element, SE&I and PP&C Office. The goal of the QRA is to communicate to (Program) management the current cost impacts and their mitigation costs (if provided). Each Element QRA is combined in the Program QRA (QRA roll up) which includes all Program cost impacts and their corresponding

mitigation costs. For each fiscal year the total cost impact is identified with a likelihood factor. Each total can then be compared to the current Program or Element (financial) reserves. Figure 4-3 shows the QRA template.

						FY13	FY14	Total FY13-18	Total FY13-18
				Total Reserves from Submit		$ 66.0		TBD	$ -
				Risk Totals		$ 367.7	$ 912.1	$ 3,512.9	$ 2,100.1
				Risk Totals with Likelihood factored for all risks with likelihood >= 50% (QRA)		$ 149.3	$ 587.8	$ 1,943.7	$ 1,943.7
				Cumulative Reserve Over QRA (for all risks with likelihood >=50%)		$ (83.3)	TBD	$ (83.3)	
				Risks/Costs/Threats/Liens - Cost Consequence by Fiscal Year					
				Risks/Costs/Threats/Liens > 50%					QRA Likelihood
NOV Trend	JAN Trend	Element	Risk ID	Description	LH	FY13	FY14	Total FY13-18	Total FY13-18
→	→	Booster		Risk Name A	100%	$ 6.0	$ -	$ 6.0	$ 6.0
→	→	Booster	11913	Risk Name B	100%	$ -	$ 0.3	$ 0.3	$ 0.3
→	→	PO		Risk Name C	100%	$ -	$ 0.6	$ 3.0	$ 3.0
→	→	LEO		Risk Name D	90%	$ -	$ -	$ 21.6	$ 19.4
				Risk Name D Mitigation		$ 2.0	$ 2.0	$ 4.0	$ -
				Risks/Costs/Threats/Liens = 50%					QRA Likelihood
NOV Trend	JAN Trend	Element		Description	LH	FY13	FY14	Total FY12-18	Total FY12-18
→	→	Booster		Risk Name E	50%	$ 2.2	$ 11.3	$ 29.2	$ 14.6
→	→	Stages		Risk Name F	50%	$ 5.0	$ 10.0	$ 25.0	$ 12.5
→	→	Stages	11904	Risk Name G	50%	$ -	$ 0.1	$ 0.1	$ 0.1
				Risks/Costs/Threats/Liens< 50%					QRA Likelihood
NOV Trend	JAN Trend	Element		Description	LH	FY13	FY14	Total FY12-18	Total FY12-18
→	↓	SPIO		Risk Name H	40%	$ 0.9	$ -	$ 0.9	$ 0.4
	N	SE&I	11625	Risk Name I	40%	$ -	$ -	$ -	$ -
				Risk Name I Mitigation	40%	$ -	$ 1.1	$ 5.5	$ 2.2
	↑	Increasing trend							
	→	Constant trend							
	↓	Decreasing trend							
	N	New							

Figure 4-3. Quantitative Risk Assessment Template

Although mitigation costs are also provided in the QRA, they do not get incorporated in the calculations (risk total, risk total with likelihood factored, cumulative reserve over QRA). The mitigation costs are provided in the QRA so that management can understand and see the cost difference between the cost impact versus the mitigation cost for each risk.

4.2.6 Risk Acceptance

The SLS risk management acceptance process follows the risk acceptance policy discussed in the SLS-PLAN-001, SLS Program Plan, in Section 3.5.5.2 Risk Acceptance. Accepted risks are risks where continued efforts to prevent/mitigate the risks are not deemed practical. A guideline is given in Figure 4-4 showing a shaded area indicating scores in which a risk may be closed verses the un-shaded area where they may be accepted.

Approval from the owning organization and the highest level of escalation is required to assign a risk the status of accepted (e.g., a SLS risk escalated to ESD requires ESD approval). Risks that

have not been escalated may be accepted by the manager of the owning organization (e.g., Element Manager for Element risks), but the next higher level of the organization will be informed (e.g., Element accepted risk listed in the monthly package presented to the SLS Program). All accepted risks will be reviewed monthly by the risk managers, whenever a change in the risk circumstances occurs, and at major program reviews. Accepted risks can be re-scored and re-classified such that mitigation is necessary.

On decisions related to technical and operational matters involving safety and mission success residual risk, formal concurrence by the responsible Technical Authority(ies) (Engineering, S&MA, and/or Health and Medical) is required. Acceptance of safety risks is discussed in further detail in SLS-RQMT-015, SLSP Hazard Analysis Requirements. For residual safety risks, the acceptance authority is defined in ESD 10010, Cross Program Safety and Mission Assurance Plan (Figure 4.1.3-1, Hazard Risk Acceptance Strategy). For residual risks to personnel or high-value hardware, the cognizant safety organization must agree that the risk is acceptable. (Reference: NPR7120.5E, Section 3.3.2 Other Technical Authority Roles.) Consideration of the residual risk for any accepted risk is required and the escalation requirement for risk acceptance is specified in the previous paragraph. Concurrence for risk acceptance is to be based on the technical merits of the case.

4.2.7 Risk Closure

A risk may be closed when further reduction activity is not possible or not practical. A guideline is given in Figure 4-4 showing a shaded area indicating scores in which a risk may be closed (provided there is not any residual safety risk and with the concurrence of the appropriate S&MA Technical Authority representative (e.g., Program CSO for Program-level risks, Element CSO for Element -level) versus the un-shaded area where they may be accepted. Conditions that may lead to risk closure:

- Mitigation has ameliorated the risk to the specified area based on the guideline in Figure 4-4
- Overcome by Events (OBE), a change in a condition such that the risk goes away or is realized
- The risk is realized and is now an issue/problem (the risk should be referred to an issues tracking list).
- Risk has been combined with another risk so that the other risk is used for tracking and disposition.

> ***Note***: The closure rationale must reference the new risk and the new risk must reference the closed risk.

In order to close a risk, approval must be given by the manager whose organization owns the risk with concurrence from the S&MA Technical Authority representative and the closure rationale must be defined and documented in the risk database. Closure requires approval from the owning organization (as stated above) and the highest level of escalation the risk has experienced during

mitigation. The closure will be reported to the next higher level of current escalation. (e.g., if closed at the Element level, then the SLS Program must be informed).

General Guideline:
Risks with these Scores may be **Closed** (Versus **Accepted**).

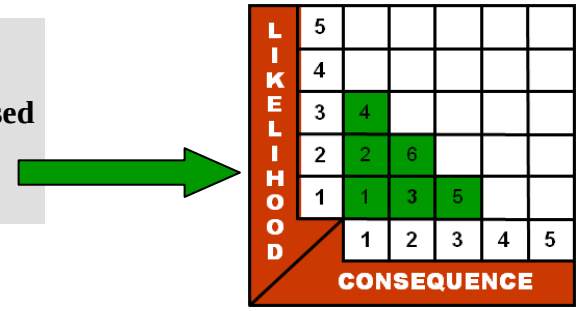


Figure 4-4. Risk/Acceptance versus Closure Guideline

4.3 Opportunity Management

Opportunities are activities that have a potential (likelihood) to benefit (consequence) the technical, safety, cost, and/or schedule baseline. They are not risk mitigation activities and may not even be activities undertaken by the organization that realizes the improvement. SLS team members are encouraged to submit opportunities, especially those that improve affordability and safety. Opportunities input by SLS follow the same review and approval process as a risk, except the score for consequence utilizes a positive versus a negative factor (see SLS Opportunity Scorecard, Figure 4-5). Opportunities input by other Programs/Projects will be monitored to determine applicability to the SLS Program and made available to Center and Agency chief technologists.

Rating	LIKELIHOOD DESCRIPTION
(1) Very Low	Qualitative: Very unlikely to occur, mgt attn not required in all cases. Strong Controls in Place Quantitative: : **P≤1/100000** (primary impact on Safety) or 1%<P<= 20% (primary impact on Cost, Schedule, or Performance)
(2) Low	Qualitative: Not likely to occur, mgt attn not required in most cases. Controls have minor limitations/uncertainties. Quantitative: : **1/100000<P≤1/10000** (primary impact on Safety) or 20%<P<= 40% (primary impact on Cost, Schedule, or Performance)
(3) Moderate	Qualitative: May occur, mgt required in some cases. Controls exist with some uncertainties. Quantitative: **1/10000<P≤1/1000** (primary impact on Safety) or 40%<P<= 60% (primary impact on Cost, Schedule, or Performance)
(4) High	Qualitative: Highly likely to occur, most cases require mgt attention. Controls have significant uncertainties. Quantitative: **1/1000 <P≤ 1/200** (for risks with primary impact on Safety) or 60%<P<= 80% (primary impact on Cost, Schedule, or Performance)
(5) Very High	Qualitative: Nearly certain to occur, requires immediate management attention. Controls have little or no effect. Quantitative: **1/200 <P** (for risks with primary impact on Safety) or P>80% (primary impact on Cost, Schedule, or Performance)

SLS Opportunity Card

-25	-24	-21	-17	-12	5
-23	-22	-19	-14	-8	4
-20	-18	-15	-11	-5	3
-16	-13	-9	-6	-3	2
-10	-7	-4	-2	-1	1
-5	-4	-3	-2	-1	

LIKELIHOOD

Opportunity

Timeframe To Initiate Handling Strategy	
Near	0 to 3 months
Mid	3 to 9 months
Far	> 9 months

BENEFIT		(-1) Very Low	(-2) Low	(-3) Moderate	(-4) High	(-5) Very High
SAFETY	Personnel	avoid negligible injury requiring first aid treatment	avoid minor injury, illness or incapacitation	avoid moderate injury, illness or incapacitation	avoid permanent disabling injury	avoid death
	Facilities, equipment, assets (avoidance)	negligible damage to non-critical ground facilities or systems	minor damage to non-critical ground facilities or systems	moderate damage to flight assets or critical ground facilities or systems, or loss of non-critical ground facilities or systems	major damage to flight assets or critical ground facilities or systems	loss of flight assets (vehicle) or critical ground facilities or systems
	Environmental (avoidance)	negligible OSHA/EPA violation non-reportable	minor reportable OSHA/EPA violation	moderate OSHA/EPA violation which requires immediate remediation	major OSHA/EPA violation causing temporary stoppage	serious or repeat OSHA/EPA violations which may result in termination of program
PERFORMANCE	Requirements	negligible improvement in requirements/design margins	minor improvement in requirements/design margins	moderate improvement in requirements/design margins	major improvement in requirements/design margins	exceptional improvement in requirements/design margins
	Operations	negligible improvement in mission objectives/ operations	minor improvement in operations	moderate improvement in operations.	major improvement in operations	exceptional improvement in operations
	Supportability	negligible improvement in supportability	minor improvement in supportability	moderate improvement in supportability	major improvement in supportability	exceptional improvement in supportability
Cost (saving)		≤$100K	>$100K but ≤$1M	>$1M but ≤$10M	>$10M but ≤$100M	>$100M
Schedule		<1 month improvement in major program milestone review	1-3 month improvement in major program milestone review	3-6 month improvement in major program milestone review	6-9 month improvement in major program milestone review	>9 month improvement in major program milestone review

Figure 4-5. Opportunity Score Card

5.0 RISK BASED ACQUISITION MANAGEMENT

Acquisition Plans will establish a continuous Risk-Based Acquisition Management (RBAM) process to integrate risk management into the acquisition process and ensure the following:

- NASA FAR Supplement (NFS) 1807.104, NFS 1815.201, NFS 1815.203- 72, NFS1846.401, and Procurement Information Circular 02-17 are implemented.
- During the solicitation process, any exchanges with industry prior to receipt of offers should include requests for any perceived risk issues associated with performance of the work.

6.0 SLS RISK MANAGEMENT TRAINING

All SLS team members that participate in the SLS Risk Management process are required to complete SLS Risk Management training. MSFC S&MA works with the SLS RM to develop and provide this training. Training records are maintained in the System for Administration, Training, and Educational Resources (SATERN) system.

7.0 RISK MANAGEMENT RECORDS

The risk management process produces various risk information. This includes:

- Risk and Opportunity information is documented in SLS Risk Packages and the SLS risk database (ARM), or similar contractor risk databases.
- Risk assessment reports and periodic risk and opportunity status reports generated by the RMs are documented in accordance with SLS-PLAN-008.
- Board risk management documentation is handled in accordance with SLS-PLAN-008 and is referenced in the unique risk records (in the risk database).
- The SLS-RPT-089, SLS Program Top Risk List, is controlled and formally updated by the SLS PCB.
- Similarly, the SLS-RPT-088, SLS SE&I Top Risk List, is controlled and formally updated by the SLS CECB.
- Each Element will decide the level of control for their Element Risk Lists.

APPENDIX A
ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS

A1.0 ACRONYMS AND ABBREVIATIONS

ARM	Active Risk Manager
C-MPSR	Comprehensive Monthly Program Status Review
CE	Chief Engineer
CE	Change Evaluation
CECB	Chief Engineer Control Board
CM	Configuration Management
CR	Change Request
CSO	Chief Safety Officer
CRM	Continuous Risk and Opportunity Management
DAC	Design Analysis Cycle
DLE	Discipline Lead Engineer
EDLE	Element Discipline Lead Engineer
ESD	Explorations Systems Development
ESI	Exploration Systems Integrated
FOM	Figures of Merit
GSDO	Ground Systems Development and Operations
HMTA	Health and Medical Technical Authority
IRWG	Integrated Risk Working Group
LSE	Lead Systems Engineer
MPCV	Multi-Purpose Crew Vehicle
MPSR	Monthly Program Status Review
MWI	Marshall Work Instruction
OBE	Overcome By Events
OPR	Office of Primary Responsibility
PCB	Program Control Board
PDF	Probability Density Function
PPBE	Program Planning and Budget Execution
PP&C	Program Planning and Control
QRA	Quantitative Risk Assessment
RAC	Requirements Analysis Cycle
RBAM	Risk Based Acquisition Management
RIDM	Risk Informed Decision Making
RM	Risk Manager
RMO	SLS Risk Management Officer

SATERN	System for Administration, Training, and Educational Resources
SE&I	Systems Engineering and Integration
SEMP	Systems Engineering Management Plan
SLS	Space Launch System
S&MA	Safety and Mission Assurance
TPM	Technical Performance Measures
UFE	Unallocated Future Expense

A2.0 GLOSSARY OF TERMS

Term	Description
Flight	The sequence of events that takes place between liftoff and landing of a transportation vehicle.
Cost Impact	Financial impact if a risk is realized. This is the cost consequence field on the Risk Scorecard.
Lien	Money owed, like a bill that will need to be paid.
Mitigation Cost	Cost associated with mitigating a risk.

APPENDIX B
OPEN WORK

All resolved TBDs, TBRs, and forward work items should be listed on the Change Request (CR) the next time the document is updated and submitted for formal review, and that will serve as the formal change record through the configuration management system.

B1.0 TO BE DETERMINED (HEADING-APPX STYLE – 11 PT. ALL CAPS AND BOLD)

Table B1-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within carets. The TBD item is sequentially numbered as applicable (i.e., **<TBD-001>** is the first undetermined item assigned in the document). As each TBD is resolved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

***Note**: When documenting open work, the book manager shall identify those items whose completion is dependent upon the delivery of data from organizations other than the Program office, including SLS Elements. This dependency shall be clearly identified in the description portion of that open task. This information is important for closure tracking purposes, and for capturing Integrated Master Schedule dependencies. (Delete this note for draft or baselined documents.)*

***Note**: Only TBDs and TBRs are used to designate Open Work items. (Delete this note for draft or baselined documents.)*

Table B1-1. To Be Determined Items

TBD	Section	Description
TBD-001		

B2.0 TO BE RESOLVED

Table B2-1 lists the specific To Be Resolved (TBR) issues in the document that are not yet known. The TBR is inserted as a placeholder wherever the required data is needed and is formatted in bold type within carets. The TBR issue is sequentially numbered as applicable (i.e., **<TBR-001>** is the first unresolved issue assigned in the document). As each TBR is resolved, the updated text is inserted in each place that the TBR appears in the document and the issue is removed from this table. As new TBR issues are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBRs will not be renumbered.

Table B2-1. To Be Resolved Issues

TBR	Section	Description
TBR-001		

B3.0 FORWARD WORK

Table B3-1 lists the specific forward work items identified during this document's Change Request (CR) review and evaluation. Each item is given a sequential number using a similar format to that for the TBDs and TBRs. For each item, include the section number(s) of this document that the open work will impact, and in the Description include the specific number of the comment from the Change Evaluation (CE), i.e., CE-10, CE-27. Do not include a placeholder for forward work items in the body of the document; list them only in Table B3-1.

Note: If there are no forward work items, do not include this subsection in your document.

Table B3-1. Forward Work

FWD	Section	Description
FWD-001	4.2.4	Risk De-Escalation
FWD-002	4.2.2	Cross Element Handling Strategies and communication
FWD-003	4.3	Develop Opportunity section, update Scorecard